PROJECT WORK IN PARASITOLOGY

SOURCES OF PARASITES

Universities and research institutes that are actively involved in parasite research will have access to a range of parasite species that are of medical or veterinary importance and can utilize this resource in their teaching (Halton et al., 2001). However, these facilities will not be available to the majority of those taking modules in parasitology and human or animal health. Wild animals will contain a variety of parasites (Avery, 1974) but these may be protected by conservation legislation. Even where they are not protected species, it is not appropriate to kill wild animals simply to satisfy an idle curiosity as to what might be living within them. Similarly, laboratory animals should not be subjected to experimental infections unless these have been sanctioned by the relevant ethics panel and are compliant with the local animal welfare legislation. Laboratory mice and rats are, however, often naturally infected with nematode parasites such as Syphacia obvealata and Aspicularis teraptera. Even humans living in affluent and hygienic surroundings often harbour parasites such as the mite Demodex spp., and the hair louse Pediculus humanus capitatis is common on children. However, any studies involving human subjects should always be undertaken with sensitivity and with full ethical approval.

Fortunately, many laboratory invertebrates are commonly infected with a range of parasites and can be used as a substitute for mice, rats, and guinea pigs. It is therefore possible to supplement observations on prepared slides of important parasite species with experiments on parasite–host relationships in living animals using invertebrate ‘models’. For example, the hind gut of cockroaches often contains a wide range of protozoa (Williams and Warhurst, 2001) of which the ciliate Nyctotherus ovalis is the most striking (Fig. 1). The hind gut regions of cockroaches are also commonly infected with the pinworm nematodes Leidynema appendiculata (Fig. 2) and Hammerschmidtthiella diesingi (Hominick and Behnke, 2001). Similarly, locusts contain a number of protozoan parasites in their gut (e.g. Gregarina garnhami) and malpighian tubules (e.g. Melamoeba locustae) while earthworms contain the gregarine parasites belonging to the genus Monocystis in their seminal vesicles (Fig. 3) and body cavity (Wakelin et al., 2001). If observations are to be made on living parasites, one must work quickly because they usually cease moving and die within a few minutes of
removing them from their hosts. Once the parasite/commensal dies, it becomes extremely difficult to find because it is their movement that attracts the attention.

Parasitoid insects (e.g. *Aphidius matricariae*), entomopathogenic nematodes (e.g. *Heterorhabditis* spp.) and the nematode parasite of slugs, *Phasmarhabditis hermaphrodita*, can be obtained from commercial companies. Similarly, several of the fly species that cause wound myiasis, such as *Lucilia sericata*, *Calliphora vicina*, and *Calliphora vomitoria*, can be obtained from either commercial sources or the local angling shop where they are sold as bait. However, the fly larvae that are sold commercially are usually supplied as post-feeding third instar larvae and are therefore not useful for feeding experiments.

![Fig. 1. Nyctotherus ovalis](image1.png)

Fig. 1. *Nyctotherus ovalis* is a large oval-shaped ciliate protozoan common in the hind gut regions of cockroaches. A = The three large darkly coloured oval bodies are *Nyctotherus ovalis*. B = Close-up of the surface of *Nyctotherus ovalis* showing the cilia that coat the surface of the cell.

![Fig. 2. Leidynema appendiculata](image2.png)

Fig. 2. *Leidynema appendiculata* – a pinworm nematode common in the hind gut regions of cockroaches.
EXPERIMENTAL STUDIES

Invertebrates and their parasites provide excellent models for investigating host–parasite relationships, symbiont (bacteria)–nematode relationships, and factors affecting transmission. It is possible to design experiments to determine the effect of various factors on the distribution of parasites within the host’s body, their abundance, and diversity. One can correlate parasite characteristics with host morphometrics, weight change, mortality, fecundity, immune status, etc. Factors affecting the host–parasite relationship could include host gender, age, size, diet, moulting (in arthropods), antibiotics, temperature, and pollutants such as sub-lethal concentrations of agrochemicals. Some examples of these will now be discussed.

PARASITES OF NEMATODES

Very little is known about the parasites of nematodes. In the absence of access to parasitic nematodes, it is always possible to extract free-living nematodes from soil, manure heaps, etc. Parasites of nematodes could be searched for using light microscope examination of sections and whole mounts may indicate the presence of microsporidia. Transmission electron microscopy would reveal viruses, bacteria, and microsporidia. Those with molecular facilities could use molecular probes although one would have to distinguish between genuinely internal infections from external surface contaminations.

Fig. 3. *Monocystis* spp., sporocyst in an earthworm seminal vesicle.
Factors affecting parasite transmission

Entomopathogenic nematodes and those that are used to control slugs provide useful model organisms for studying factors that affect parasite transmission. The nematodes can be obtained cheaply from a commercial source and one can test their effect on a wide range of potential invertebrate hosts under both laboratory and field conditions (e.g. Iglesias et al., 2001; Wilson et al., 1994). Morley and Morritt (2006) provide an experimental design for studying the effect of the nematode *Phasmarhabditis hermaphrodita* on non-target aquatic molluscs that could be adapted to investigate the effect of different nematodes/potential hosts. Similarly, the attractiveness of the nematodes to different types of mucus could be assessed under a variety of conditions such as temperature, pH, age of larvae (e.g. see Hapca et al., 2007, for a possible experimental design) or one can observe whether or not the hosts are able to detect and avoid areas containing the infective stages (e.g. Wilson et al., 1994). The presence of ‘wild’ entomopathogenic nematodes can be determined by exposing waxmoth larvae to different soils or single soil types under different conditions (e.g. temperature, moisture content) and their behaviour/effects compared with those of nematodes bought from commercial sources. The influence of pollutants such as agrochemicals, oils, and heavy metals can be determined by including them as one of the variables in the above experiments.

The interactions between co-infections

Entomopathogenic nematode species and the slug parasite *Phasmarhabditis hermaphrodita* provide excellent models for studying the development of co-infections. For example, one can compare the consequences of simultaneously infecting a host with two parasitic nematode species, or of prior infection of the host with a parasitoid. One could monitor the expression of heat-shock proteins in host, nematode, and bacteria at different stages of infection, or determine the effect of host size and initial infective dose on the development of the infection.

FACTORS AFFECTING THE ENCAPSULATION RESPONSE OF INSECTS

The haemolymph of caterpillars such as the cabbage white butterfly *Pieris brassicae*, shows a rapid encapsulation response. This can be triggered experimentally by injecting latex beads or similar small objects into the haemolymph (blood) and then killing the insect after a set period of time, extracting the beads and observing the extent of the encapsulation response.
Dying the bead makes it easier to find them and those with the facilities could study them so they displayed different antigenic properties. By pre-exposing the caterpillars to biological control agents such as viral diseases, one can determine how these affect the encapsulation response.

Similarly, the haemolymph of even healthy insects often contains bacteria. These bacteria are probably symbiotic although their relationship with their insect hosts is often poorly understood. Because the bacteria can be grown on standard nutrient agar or potato-dextrose agar, and insects such as cockroaches, locusts, mealworms, and cabbage white butterflies can be maintained relatively easily, it is possible to design experiments to examine the relationship without the need for complex and expensive equipment. After puncturing the cuticle with a sharp needle, the haemolymph can be withdrawn using a microcap without killing the insect. The bacterial density can then be determined by standard microbiological techniques. The consequences of various treatments can therefore be tested to determine the relationship between the bacteria and the insect. For example, does the microbial population change during moulting or pupation? If the insect diet includes antibiotics, does this affect the haemolymph microbial density? Is insect growth compromised by the absence of bacteria? What would happen if the cultured bacteria were injected into the insect?

PREVALENCE OF DEMODEX INFECTIONS

There is a lot of discrepancy in the literature on the prevalence of Demodex in humans and therefore a basic study of factors such as presence, regions of the body infected, and epidemiological factors such as host gender, age, use of skin products, etc. could be helpful. Laboratory animals such as mice, rats, and rabbits are infected by their own species of Demodex but very little is known about their prevalence and transmission. It would therefore be possible to design studies to investigate Demodex infections in laboratory animals without necessitating intentional infections and utilise animals that may be being subjected to other (approved) experimental treatments.

BIOLOGY OF HAIR LICE (PEDICULUS HUMANUS CAPITATIS)

Hair lice are common on children and one could study factors affecting survival time off the host and the length of time it is possible to extract human DNA from the insect. Obviously, anything involving humans and human DNA would require ethical approval.
REFERENCES


Wilson, M.J. et al. (1994) Laboratory tests of the potential of entomopathogenic nematodes for the control of field slugs (Deroceras reticulatum). Journal of Invertebrate Pathology 64, 182–187.